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Agrarian Structure in Poland

The Myth of Large-Farm Superiority

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Policymakers who currently promote large, mechanized farms in Poland to the detriment of smaller farms should reevaluate these policies. Smaller farms are more labor-intensive than large farms, and are less efficient.



Summary findings

In Poland, present policies are aimed at promoting large, mechanized farms over smaller family farms. These policies are based on the perception that large farms offer real economies of scale. But international evidence indicates that such large, mechanized farms are generally less efficient and use less labor than small family farms.

So, van Zyl, Miller, and Parker analyzed the relationship between farm size and efficiency in Polish agriculture.

They used two different methods to do so. First, they determined differences in total factor productivity

between small and large farms. Then they used Data Envelope Analysis to estimate scale efficiencies.

The results show that, for the sample of farms analyzed:

- Large farms are not more efficient than smaller farms.
- Smaller farms are more labor-intensive than larger farms.

These results have important policy implications for farm restructuring in Poland and other transition economies facing similar issues and conditions.

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AGRARIAN STRUCTURE IN POLAND: THE MYTH OF LARGE FARM SUPERIORITY¹

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The issue of what is the most appropriate farm size to maximize agricultural productivity has an extensive literature. In Poland, present policies are aimed at promoting large-scale, mechanized farms over smaller family farms. These policies are based on the perception that there are real economies of scale present that favor large farms. But these perceptions are contrary to international evidence, which indicates that a large-scale, mechanized farm sector is generally inefficient and uses less labor than small-scale family farms. Thus, there is ample motivation for a detailed analysis of the farm size-efficiency relationship in Polish agriculture.

Two different methodologies are used to determine the farm size-efficiency relationship in two regions of Poland: first, total factor productivity (TFP) differences between small and large farms are determined; and second, non-parametric Data Envelope Analysis (DEA) is used to estimate scale efficiencies.

Despite a history of policies favoring relatively larger, mechanized farms in Poland, the results show that, within the sample of farms analyzed, (i) large farms are not more efficient than smaller farms; and (ii) smaller farms are relatively more labor intensive in their mode of production. These results have important policy implications with respect to farm restructuring for Poland and other transition economies facing similar issues and conditions.

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International evidence indicates that a large-scale, mechanized farm sector is generally less efficient, especially when compared to small-scale family farms.

Although there may exist real economies of scale, they are mostly “false” because they are usually the result of policies that favor larger farms over small farms. The relationship between productivity and farm size in Polish agriculture has not been adequately investigated. The issues of whether larger, mechanized farms are more economically efficient than smaller farms has not been analyzed in detail. Yet results of such an analysis could yield important findings for agricultural policy in Poland.

This paper, therefore, seeks to address the farm size-productivity relationship in Polish agriculture, first, by considering international empirical evidence on the farm size-efficiency relationship in agriculture. This is followed by a discussion of Polish farm structure and policies of farm restructuring. Third, an analysis of the farm size-efficiency relationship for two agricultural regions of Poland is undertaken using cross-section farm-level data. Both total factor productivity comparisons between farm size categories and non-parametric Data Envelope Analysis are used in the analysis. The paper concludes with implications of these findings for farm restructuring in Poland.

International Experience On Economies Of Scale, Farm Size and Productivity

Larger farms are often actively promoted over small farms because it is argued that significant economies of scale exist in agriculture. However, the general consensus

in the literature is that economies of scale do not exist in agriculture, except under specific, usually temporary, circumstances. Empirical evidence demonstrates that family-type farms are generally more efficient and superior to other types of farming because of the way in which labor relations are organized. Patterns of resource utilization indicate that smaller farms use labor and land with greater intensity than large farms. These findings suggest that agricultural policies should not favor one form of agricultural production over another.

Economies of Scale in Agriculture

Most of the arguments for promoting larger farms over smaller ones rely on the assumption that there are significant economies of scale in agriculture. The sources of economies of scale are said to include: (i) lumpy inputs, such as farm machinery and management skills, that can only be utilized on farms above a minimum size; (ii) advantages in the credit market and in risk diffusion arising from collateral associated with the ownership of large holdings; and (iii) processing plants that can realize economies of scale, usually through wage plantations (Binswanger *et al*, 1995; Johnson and Ruttan, 1994).

However, many options are available to help smaller farms circumvent the negative effects of economies of scale: (i) machine rental can permit small farmers to mitigate the economies of scale advantage in all but the most time-bound of operations, such as plowing and planting in dry climates, or harvesting where climatic risks are high; (ii) management and technical skills can be contracted from specialized consultants and advisory services, or can be provided by publicly financed extension services; (iii) small farmers may be able to access credit through cooperatives where

many farmers may pool their land for use as collateral, and various sharecropping arrangement, where the credit risks are shared by farmer and landowner; and (iv) the coordination problem associated with processing in plantation crops can be solved at a relatively low cost through contract farming.

Although lumpy inputs, credit and risk diffusion, and processing plants can, therefore, be important temporary sources of economies of scale, market solutions are generally available that can mitigate the effects of the scale economies. In any case, the concept of economies of scale is problematic in practice. Theoretically, economies of scale are defined by a production function that exhibits a more than proportional increase in output for a given increase in magnitude of all inputs. However, there is rarely a situation when an increase in magnitude of some inputs does not imply a change in the utilization of other factors of production (Peterson and Kislev, 1991).

The general consensus of researchers who have empirically investigated it is that *economies of scale do not exist in agriculture, except under specific circumstances* (Johnson and Ruttan, 1994; Peterson and Kislev, 1991). Chavas and Aliber (1993), for example, found virtually no scale economies in dairy production in Wisconsin, and the limited initial scale economies they observed were attributable to lumpiness of certain inputs.

Public policies that focus resources on supporting large over small farms are therefore unlikely to be successful in terms of realizing significant scale economies. A more appropriate policy is one that facilitates the formation of markets to enable

small farmers to gain access to essential productive resources and to create a “level playing-field” for all agricultural producers.

Farm Size and Productivity

The apparent existence of economies of scale has led researchers to investigate more closely the relative performance of small and large farms. Over the past three decades, various studies have assessed the productivities of farms of different sizes. In general, these studies demonstrate a higher level of factor productivity on small farms than on large ones; however, the studies often suffered from methodological shortcomings that have raised questions about their validity. More recent studies have attempted to address these issues.

Based on Indian farm management data from the late 1950s, Sen (1962) observed an inverse relationship between farm size and yields per unit area. Since then, many articles have been written that have examined this relationship. Berry and Cline (1979) carried out a detailed empirical investigation into the relationship between farm size and productivity covering data from Brazil, Colombia, the Philippines, (West) Pakistan, India, and Malaysia. They conclude that “the evidence presented...points to systematically higher land productivity on small farms than on large ones, and to total factor productivities that are at least comparable” (Berry and Cline, 1979: 4).

Other authors who found that an inverse relationship exists have included: Cornia (1985), who found a strong negative correlation between farm size and factor inputs and yields per hectare in 12 out of 15 developing countries for which he analyses

farm management data from FAO; Bardhan (1973), who found that the elasticity of output per acre with respect to acreage in selected Indian villages is mostly negative; Khusro (1968), who similarly found that if acreage, uncorrected for its level of fertility is taken, then as acreage increased, gross output per acre decreased; Carter (1984), who concluded that the inverse relationship is due to specific characteristics of small farms; and Kanel (1967), who discovered that it is not only output per acre, but net return per manday, and the ratio of values of outputs to inputs that were negatively correlated with farm size.

In Kenya, a World Bank study (World Bank, 1983) that investigated the higher efficiency of small versus large farms, found that output per hectare was 19 times higher and employment per hectare was 30 times higher on holdings under 0.5 hectare than on holdings over 8 hectares. At the national level, this meant that a 10 percent reduction in average farm size would increase output by 7 percent and employment by over 8 percent. Binswanger *et al* (1995) report similar results for many other countries. Evidence is also available at the macro-level, but only in terms of physical yields—an imperfect indicator of efficiency. Prosterman and Riedinger (1987) using data from 117 countries, show that 11 of the top 14 countries in terms of grain yields per hectare are countries in which small-scale, family farming is the dominant mode of production.

Based on the observation that there are no significant economies of scale in agriculture, most studies that consider the relationship between farm size and productivity assume that returns to scale in agriculture are constant (Barnum and Squire 1978; Berry and Cline 1979; and Johnson and Ruttan 1988). In the absence

of decreasing returns to scale some other explanation of the inverse farm size-productivity relationship must be sought. Berry and Cline argue that “if returns to scale for inputs actually utilized are constant, then the crucial determinant of the farm size-productivity relationship becomes the *behavioral pattern of resource utilization by farm size*” (Berry and Cline, 1979: 7; italics added).

Resource Use and Farm Size

Closer analysis of the pattern of resource utilization by farms indicates that smaller farms use factors of production with greater intensity than large farms. On the one hand, it is observed that the apparent benefits large farms enjoy over small farms with respect to land and capital are due mainly to market imperfections. These imperfections can be addressed through the promotion of markets to serve small farms. On the other hand, it is observed that small farms use labor resources more intensively than larger farms. For example, Cornia (1985) finds a negative elasticity for resource inputs with respect to land, and higher land use intensity on smaller farms. For land, it is argued that large farms underutilize the total land area at their disposal by, for example, having an output composition that is more geared to land extensive enterprises (e.g., cattle or other livestock projects), while smaller farms practice multi-cropping, which increases land utilization and raises the total value of output for a given area of land.

Under conditions of perfect competition, we would expect these differences to be equalized over time. The fact that they continue to persist many years after being identified suggests that there are underlying economic factors that go beyond

essentially technical, descriptive explanations. The basis for this economic analysis revolves around the existence of imperfections in the markets for factors of production that result in small farms facing a lower effective price for labor and higher effective prices for land and capital. This leads to small farms using more of the relatively abundant factor—labor, and less of the relatively scarce factors—land and capital, whereas large farms treat land as an abundant resource, and substitute capital for labor.

Land. Larger farms face an implicit cost for land that is lower than its opportunity cost. This is due to: (i) the existence of a limited land market in many developing countries, where the ownership of land changes only slowly over time, and in some areas where the market for land is virtually nonexistent; (ii) large landowners sometimes being absent from their land, so having little direct relationship with the land, and as a consequence undervaluing its merits as a productive resource; (iii) large farmers having better access to credit, so they can buy land more easily at relatively low, sometimes negative, real rates of interest; (iv) “distress” sales that enable large landowners to purchase land from small farmers at lower prices, where land prices do not fully reflect the risks of parting with land for small farmers, who if they sell must seek some risky alternative; and (v) land being held as an asset or for prestige purposes that will tend to reduce its productivity. Barnum and Squire (1978: 198) present results from their analysis that show land is consistently underused by large farms, and they “attribute this result to imperfections in the land market, especially the tendency to treat land as a non-economic factor in intra-family transactions”.

Capital. Larger farms also face an implicit cost for capital that is often lower than its opportunity cost. They are often able to gain easier access to official subsidized credit schemes, and obtain capital at cheap rates of interest. These imperfections are often exacerbated by macroeconomic policies that maintain a strong exchange rate, meaning that large farmers can import capital equipment at effectively subsidized prices. Small farmers, by contrast, lack access to formal credit markets, and depend on informal markets that have high real rates of interest. Part of Feder's (1985) model relates to capital market imperfections, where obtaining working capital depends on the farm size, i.e., on the collateral offered. His model shows that under these conditions a systematic relationship between farm size and productivity exists. This is confirmed by the research of Carter and Kalfayan (1989) and Carter (1994).

Labor. Small farms commit more labor to production than large farms. This is due to the existence of a dual labor market. On small, family labor-based farms, each member receives a share of the total value product of the farm. This means that an individual's wage will be less than the marginal product, and closer to the average product. Consequently, an individual on a family farm will supply more labor at a lower marginal value product (with a lower implicit wage rate), than would be the case if the marginal value product of labor were being equated to the market wage. In fact, even if marginal value product equalization were to take place, family workers would discount the market wage due to the uncertainty of finding work. None of these situations apply in the large farm sector, where the marginal value

product of labor will be at least equal to, and in the case of monopsony power, greater than the market wage rate (Chattopadhyay and Rudha 1976).

The literature demonstrates that family farms are generally more efficient and superior to other types of farming because of the way in which labor relations are organized (Berry and Cline, 1979; Binswanger *et al*, 1995; Deininger, 1993; Johnson and Ruttan, 1994; Lipton, 1993). Family farms are by definition farms where the owner is the operator and where the family provides the large bulk of the regular labor requirements throughout the year. While the definition of family farms does not exclude the hiring of other people, especially in a part-time capacity when related to seasonal labor, they tend not to rely too much on such activity and can avoid moral hazard problems because family farm members typically work side-by-side with hired labor and can monitor work effort. Hired labor on large farms is far harder to monitor and may result in shirking. The use of less labor as farm size increases is well documented (e.g. Ghose, 1979; Van Zyl *et al*, 1995).

Also underlying the establishment and maintenance of large-scale farms is the misguided perception that there is a relationship between modernization, specifically mechanization, and large farms. This has been clarified in the literature (Johnson and Ruttan, 1994). Capital intensity is explained by the substitution of capital for labor because of high wages. This substitution process, brought about by changes in relative factor prices (Peterson and Kislev, 1991), indirectly encouraged the formation of larger farms. It is argued that machinery permits farmers to work progressively larger units of land (Hayami and Ruttan, 1985). However, a closer examination of the application of capital and machinery in agriculture suggests that although the

number of workers can be increased substantially without increasing labor supervision costs with stationary machinery, in agriculture, labor and machines are both mobile, making supervision expensive and increasing management costs. Also, agricultural tasks are sequential in nature due to the annual cycle of production; this limits the opportunities for specialization and division of labor, which creates few advantages to expansion beyond the size of owner-operator (Brewster, 1950).

Criticisms of the Findings

Although there appears to be strong empirical evidence supporting the existence of a farm size-productivity relationship, the basis for this finding has been criticized. Barbier (1984) has criticized the use of pooled data. He finds no set relationship in Hoogly district in West Bengal, and concludes that “there does not exist one form of relationship but multiple forms —inverse or not —holding for different places in India, along different size distributions and for different types of crops”. Carter (1984) has also pointed out the possibility of multicollinearity among the independent variables, e.g., soil quality and farm size.

Patnaik (1972) has criticized the assumption that scale and size are closely and positively correlated. Using data from the Farm Management Survey in India, she shows that inputs and outputs per acre both decline as farm size increases, but the opposite is true when scale is considered. The importance of this finding relates mainly to issues of policy, as it can be seen from her analysis that size in itself is not an adequate measure on which to base agricultural policy. Closely related to scale is the issue of technical change. Deolalikar (1981), using cross-section regional data

from agricultural censuses in India, shows that with technical change the inverse relationship breaks down. He points out that much of the empirical work on farm size dates from before the green revolution. In West Godavari, for example, in 1958-60 there was an inverse relationship between size and output per acre, but by 1969-70 this relationship had become positive, which he suggests is due to more intensive use of fertilizer. He argues that although labor market dualism is important, with technical change the share of labor in total output will decline, and other current inputs, e.g., fertilizer, will become more important.

Other writers (Binswanger *et al*, 1995) have argued that many of the studies on farm size suffer from analytical shortcomings. For example, studies often do not account for differences in land quality or labor productivity; they use physical yields; and they do not account for differences in size and ownership holding size. More accurate measures of efficiency are based on the difference in *total factor productivity* between small and large farms, and the difference in profits per unit of capital invested, net of the cost of family labor. However, if these more appropriate productivity measures are used, the earlier findings are reinforced rather than contradicted. Binswanger *et al* (1995) find that: (i) *the productivity differential favoring small farms over large farms increases with the differences in size*, implying that it is largest where inequalities in landholdings are the greatest, in the relatively land-abundant countries of Latin America and Africa, and smallest in land-scarce Asian countries where farm size distributions are less equal; and (ii) the highest output per unit area is often achieved not by the smallest farm size category

but by the second smallest farm size class, suggesting that the smallest farms may suffer from diseconomies of scale, e.g., due to severe credit constraints.

Any observed positive relationship between farm size and productivity is the result of market imperfections, and then only when more than a single market is imperfect. For example, if credit is rationed according to farm size, but all other markets are perfect, land and labor market transactions will produce a farm structure that equalizes yields across farms of different operational size. But if there are imperfections in two markets, land rental and insurance, or credit and labor, a systematic relationship arises between farm size and productivity (Binswanger *et al*, 1995).

In countries, such as Poland, where markets facing small farmers for any combination of factors of production (e.g., labor, land, credit, land rental, insurance) are often imperfect or missing—at least for some farmers and in general those who are small, this may give rise to apparent economies of scale over the short term. However, these economies of scale are “false” in the sense that they are only temporary, and the result of deliberate elimination of, or restrictions on factor markets.¹ Where market development is promoted, economies of scale diminish and eventually disappear. The issue, thus, is not to pursue a farm structure that over the short term captures these benefits, but over the longer term locks a country into an inefficient and inequitable structure centering on large-scale, mechanized farms, but rather to encourage more competitive markets. Over-emphasizing modernization, restructuring, mechanization and other similar concepts that imply

the use of more capital to labor than that dictated by economic realities should be discouraged.

Structure and Size in Polish Agriculture

Polish farm structure is characterized by three distinct sectors: state farms, cooperatives and private farms (Table 1).

**Table 1: Agricultural Landuse by Major Sector
(Thousand hectares, with proportion of total in brackets)**

Sector	1985	1990	1992
Private farms	14,425 (77%)	14,228 (76%)	14,264 (77%)
State farms	3,509 (19%)	3,490 (20%)	3,304 (19%)
Co-operative farms	770 (4%)	650(4%)	678 (4%)
Total	18,844	18,720	18,644

Source: Central Statistical Office (CSO, 1993)

State Farms

The concentration of state farms varies substantially between regions. It is higher in the west and north (40 percent of all farmland) and lower in the central and southern regions (10-15 percent). State farms are generally very large—5,000 to 6,000 hectares is not uncommon—and tend to be horizontally integrated in groups of several large farms, as well as vertically integrated with feed mills, seed farms, and poultry processing units (World Bank, 1990). More than half of state farms are over 1,000 hectares in size. In 1988, state farms produced 19 percent of farm output and marketed more than 50 percent of the total production for some crops, e.g.,

wheat and other grains (CSO, 1988). The level of mechanization on state farms is higher than on private farms. Although the average number of tractors per area was similar at 6.5/100 hectares in 1991 (Gomula *et al*, 1991), tractors on state farms generally were much more powerful. State farms' contribution to rural employment is, however, relatively lower than private farms. While accounting for roughly 19 percent of the agricultural land, they employed only 10 percent of the agricultural workers in 1992 (Wojciechowski, 1994).

At the start of the economic program of transition from a centrally planned to a market economy during the late 1980s, the agricultural sector in Poland was highly protected and subsidized. Subsidies to producers in the form of price support ranged from 3.4 to 4.8 percent of GDP in the period 1986 to 1989. This was supplemented by input subsidies of 1.3 percent of GDP (Wojciechowski, 1994). The state farm sector, however, benefited disproportionately from the subsidies (Table 2).

Table 2: Percentage Producer Subsidy Equivalents, by Sector and Commodity, 1987 (percent)

Sector	Wheat	Rye	Barley	Beet	Seed	Pork	Beef	Milk
State	67.4	69.3	75.2	49.7	69.0	36.6	3.9	41.1
Private	47.1	48.1	58.7	31.0	43.5	28.1	3.9	22.7

Source: Foreign Trade Institute (1989)

State expenditures were reduced dramatically and farm subsidies were abruptly terminated when the state experienced a fiscal crisis with the collapse of central planning. Subsidies for price support to farmers declined from more than 4.0 to 0.2 percent of GDP from 1989 to 1990. Similarly, agricultural input subsidies fell from

1.3 to 0.3 percent of GDP. State farms, the major beneficiaries of agricultural subsidies, were thus left without support and had to adjust to the new conditions of the market (Wojciechowski, 1994).

This situation, as well as a deterioration of overall economic conditions, e.g., high inflation, the limited availability of capital and increased costs of inputs, resulted in many state farms being unable to meet their financial commitments. The level of inputs on state farms almost halved between 1990 to 1992, while the use of fertilizer fell even further (CSO, 1993). Lower levels of investment and input use were accompanied by extensification of crop and animal production. For example, cereals replaced more intensive crops, such as sugar beet or potatoes (Wojciechowski, 1994). The drought of 1992 worsened the financial plight of state farms (Institute of Agriculture and Food Economics, 1994).

As a result of the fiscal squeeze, the state farm sector and most individual state farms have run at a loss since 1991. A change in the accountancy system allowed this loss to be explicit in farms' financial statements (Kondraszczuk *et al*, 1992). By June 1990, 70 percent of state farms had lost their credit-worthiness. By the end of 1993, state farm liabilities were in excess of 18 billion PZL (APA, 1994). There was, thus, a clear need for restructuring the state farm sector, and the Agriculture Property Agency (APA) was therefore established on January 1, 1992 to privatize state-owned agricultural land.

State Farm Restructuring

The Polish Government's financial capacity is presently limited, and funds are not available to continue to subsidize agriculture. On the contrary, the Government expects to receive revenues from the proceeds of the privatization of state agricultural land and assets. While the privatization process was perceived to be well on track in most sectors by the early 1990s, the privatization of state farms had encountered major difficulties (APA, 1994).

APA was set up as an agency of the Treasury, but acts as an independent entity. It thus has characteristics of both a bureaucratic and private organization. It does not receive direct government assistance, but has to rely on loans from the financial sector and proceeds (rents and sales) from assets under its control. All state agricultural land is being transferred to APA with the objective of privatizing it as soon as possible. However, a major impediment to this process is that when APA takes over a farm, it also assumes responsibility for all outstanding debt, which averages nearly 50 percent of the market value of all farm assets. This debt has to be serviced from the proceeds of the farm, through either the privatization of assets or the returns to farming, or some combination (APA, 1994).

Despite this difficulty, APA has achieved considerable progress in its first two years of operation (1992-1993): (i) an action program has been prepared to restructure, transfer, privatize or close down agro-processing enterprises on state farms—liquidation of non-agricultural property has proceeded faster than liquidation of farms; (ii) it has completed the take-over of the majority of farms, and began the

transfer process for the remaining ones; and (iii) it has privatized more than 35 percent of the former state agricultural land through lease, sale or give-away.

APA uses four basic processes to privatize state land it acquires (APA, 1994; World Bank, 1994):

- **Land sale** is regarded as the preferred manner of privatization. Reprivatization claims of former owners present problems with land sales, as does the lack of finance on the part of buyers, which restricts the number of buyers.
- **Leasing of land** requires less money and is quick to execute. It also allows for easy sub-division of large farms. In general, however, farmers need outside financial help to meet obligations as proceeds from the farms do not provide sufficient revenue. Individual farmers are used to having ownership rights and do not easily accept leasing as a contractual form governing land use. However, APA does its best to make the lessees feel secure on the land.
- **Company agencies** are limited special agencies formed in cooperation with the Ministry of Agriculture to manage both animal and plant breeding farms. In general, the operational assets are transferred to the company, but not the land, which is leased. These companies are wholly owned by APA.
- **Management contracts** are similar to leasing. However, the manager does not farm for his own account, but works for the APA. In general, management contracts are used when there is no possibility of leasing.

Thus, a satisfactory procedure already exists for transferring ownership of state farms. However, the privatization process has been handicapped by a number of practical and policy issues. More than four-fifths of the land already privatized is being leased, while only five percent has been sold (Miller and Wojciechowski, 1994). Reasons for this imbalance include: insufficient private resources to buy land; low profitability of agriculture; administrative constraints with respect to land registration; land reprivatization claims; and institutional and political constraints to more rapid land sales—strong pressure to sell state assets not too cheaply with prices based on non-market or book values rather than on market values; perceptions that future competitiveness of Polish agriculture requires large areas under single control so as to allow for economies of scale; and internal concerns at APA regarding its long term role and the tenure of personnel. As a result, transformation is not popular across the entire political spectrum in Poland, particularly as it reveals hidden unemployment.

Moreover, the farm size issue has also not been resolved satisfactorily. In general, APA is in favor of smaller farms and acknowledges the superiority of family farms (Tanski, 1994). However, the prevailing opinion is that specific circumstances in Poland, enable large, mechanized farms to cope better financially, especially with respect to input and output marketing. Reasons given for this advantage include: the quality of existing infrastructure on farms; the policy environment; the lack of access to European Community markets; the concentration in agro-processing; and the collapse of agro-services and transportation difficulties.²

The belief in the superiority of large-scale mechanized farms under these conditions is also borne out by the reluctance to restructure state farms by creating farms of less than 200 hectares in size. State farms average about 2,300 hectares in size, while the average parcel of land offered for privatization by APA is generally 600 hectares—far higher than the average private farm size. Thus, although the privatization of state farms is accompanied by some restructuring into smaller units, these new farms maintain the general characteristics of large-scale mechanized farms. Moreover, criteria for business plans on which the restructuring is based accentuate modernization and mechanization (APA, 1994).

Private Farms

Polish agriculture never underwent complete collectivization. The dominant private sector mainly consists of small farms. Only 8 percent of private farms are larger than 15 hectares, yet they cultivate 24 percent of the total of private farmland (Table 3).

Table 3: Private Farm structure in Poland, 1991

Category	Size (Hectares)	Number		Area		Average size (Hectares)
		(Thousand)	(Percent)	(Million. hectares)	(Percent)	
Small	< 5	1,108	48.7	2.7	19.9	2.4
Medium	5-10	692	30.4	4.4	32.4	6.4
Large	> 15	183	8.0	3.3	24.3	18.0

Source: Institute of Agricultural and Food Economics (1990); World Bank (1991)

The Polish Government has sought to promote a long-term policy of land consolidation in an attempt to restructure agriculture. Between 40,000 to 60,000

hectares of privately-owned farmland were consolidated annually. While the principal effect has been on middle-sized commercial farms that depend largely on farming for a living, the smallest farms have also been targeted. Farms, ranging in size from 5-15 hectares, are declining in number as they are consolidated either with official financial support, bought by larger farms (over 15 hectares), or purchased by the State in exchange for a pension. Until 1989, land consolidation was also fostered by restricting access to inputs, operating and development credit, and extension services; by encouraging older farmers to retire and sell their land in exchange for a pension; and by deliberately not producing the appropriate size machinery for smaller farms. The overpowered equipment used on medium-size Polish farms is particularly noticeable (Report of the Polish Task Force, 1990).

Analyzing the Farm Size -Efficiency Relationship in Polish Agriculture

The issue of optimal farm size remains unresolved in Poland. Promotion of larger farms is based on the perception that there are real economies of scale present in Polish agriculture that favor large farms over smaller family farms. But these perceptions are contrary to international evidence, which indicates that a large-scale, mechanized farm sector is generally inefficient, especially when compared to small-scale family farms. No study has, however, been carried out to date that adequately analyzes the relevance of the farm size-productivity relationship in Polish agriculture. There is, thus, ample motivation for a detailed analysis that should allow for an evaluation of the present policies of small farm consolidation and state farm restructuring.

There is a paucity of accurate farm-level data on the performance of large-scale, mechanized farms, both state-owned and private. The old state farms are in a state of neglect with many facing bankruptcy. Newly privatized farms have not been in operation long enough to justify analysis. Therefore, the analysis in this paper utilizes data on existing private farms to investigate the farm size-efficiency relationship.

Two different methodologies are used to determine the farm size-efficiency relationship in two regions of Poland: first, total factor productivity (TFP) differences between small and large farms are determined; and second, non-parametric Data Envelope Analysis (DEA) is used to estimate scale efficiencies. These two approaches to determining efficiency are complementary. TFP provides a measure of overall productivity, but does not analyze the contribution of different sources of efficiency. By contrast, DEA isolates scale efficiency from technical and allocative efficiency. Both approaches meet the requirements for appropriate methodologies to measure farm productivity covered in Binswanger *et al* (1995).

Data

Surveys conducted by the Institute of Agricultural and Food Economics (IAFE) in Warsaw, Poland provided the data for the analysis. IAFE conducts these surveys every year, but in this paper only 1993 data were used. In 1993, 736 private farms were surveyed. For these surveys, Poland was divided into nine relatively homogeneous regions. However, the analysis in this paper uses data from only two of these regions: Region 1 is represents the area around the capital of Warsaw—

Stoleczny; and Region 8 represents the mid-west of Poland—Srodkowo-Zachodni (Table 4).

Table 4: Surveys Included in the Farm Size-Efficiency Analyses

Region	Predominant Type of Farming	Year Covered by Survey	Number of Farms Surveyed
Region 1: Stoleczny	Mixed farming: Grain, livestock	1993	97
Region 8: Srodkowo-Zachodni	Mixed farming: Grain, livestock	1993	151

The sample of farms in each region was selected according to specific criteria, for example farms smaller than three hectares were excluded and only progressive farmers were selected. The selection within these criteria is random. However, due to this procedure the sample does not represent the actual structure of farming and the size distribution of farms in the regions surveyed. Typical farms included in the sample are generally more market oriented and have higher productivity than average farms. In 1993, the productivity of those farms was on average more than 40 percent higher than for the average farm.

Data were collected on-farm by using a Farm Record Book that covers the following: (i) cash transactions (trade); (ii) credit transactions (trade) and reconciliations; (iii) trade of crops, animal and processed products; (iv) monthly work of family and hired labor (hours); (v) disposal of own machinery and custom hire (hired machinery); (vi) farm inventory and changes; and (vii) description of farm (personal data, location of farm, cropping structure, taxes and insurance paid, farmer's intentions and goals,

etc.). This information was then processed following internationally accepted accounting practices to develop balance sheets, income and cash-flow statements. These data are generally of good quality and have been used in several analyses (Miller *et al*, 1994; Polish-American Extension Project, 1995).

The final data for each farm in the different samples used in the analysis involve inputs and outputs. These were aggregated to give two output series—crops and livestock—and seven input series—land, buildings, livestock and machinery representing the stock inputs, and crop-specific (seed, fertilizer), livestock-specific (feed, dips) and other inputs (electricity, etc.) representing flows (Table 5).

Table 5: Summary Size Characteristics of Farms Analyzed

Variable	Region 1: Stoleczny			Region 8: Srodkowo-Zachodni		
	Average	Maximum	Minimum	Average	Maximum	Minimum
Farm Size:						
Actual size (ha)	12.87	53.88	3.56	14.69	101.53	3.19
Quality-adjusted (ha)	13.87	44.65	1.44	14.71	82.44	2.36
Output:						
Crops (PLN)	8,365	19,671	1,365	13,554	82,990	2,215
Livestock (PLN)	7,906	24,512	134	12,472	54,140	0
Stock Inputs:						
Land (PLN)	16,737	52,278	2,311	20,746	131,901	3,769
Buildings (PLN)	29,076	102,075	4,075	22,324	85,983	1,475
Livestock (PLN)	5,505	20,371	12	6,714	26,467	0
Machinery (PLN)	29,353	118,851	2,412	20,814	115,896	399
Flow Inputs:						
Crop inputs (PLN)	1,701	5,514	310	3,286	24,338	747
Livestock (PLN)	4,099	13,255	93	7,158	30,310	2
Other inputs (PLN)	1,474	4,072	201	2,144	7,052	367

The data from these surveys specifically allow for the elimination of the problems with earlier studies. In particular, farm size has been adjusted for differences in land quality within regions by using the land classification system and land tax coefficients.³ This methodology is commonly used in Poland to normalize land

areas.⁴ In this paper all land is quality-adjusted and expressed in terms of Land Class IV equivalents.

Another important point is that, within a specific region, all farmers face essentially the same sets of prices because they buy from the same input suppliers and output markets for most commodities were controlled. This implies that monetary values of outputs and inputs (revenues and costs in the relevant categories) can be treated as quality adjusted quantities,⁵ which greatly enhances the reliability of the analysis as it also normalizes input and output quantities by eliminating the effect of quality differences.

All analyses were conducted separately for each region or survey. Because the analysis implicitly neglects possible production uncertainty, e.g., due to weather effects, the underlying assumption is that all farmers within each survey face similar production uncertainty. This seems to be appropriate given that the analysis is conducted for a given production year and covers one relatively homogeneous region at a time.

Total Factor Productivity Measures

Total factor productivity (TFP) for different farm size categories is a superior indicator of the farm size-efficiency relationship compared to partial indicators, such as physical output or value of agricultural output per unit of operated area, as it accounts fully for differences in labor and other input use. All quantity measurements used in the TFP analysis were annual flow variables. Stock variables were transformed into flow variables by calculating the equivalent annuities based on

the relevant interest rate for that period and region, the average useful life of the particular assets, and the applicable tax rate.⁶ Thus, the analysis presented measures all inputs and outputs as annual flows expressed in monetary terms.

Private Total Factor Productivity Analysis

TFP values for different farm size categories have been calculated and compared for each of the farm surveys (Table 6). The most efficient farm was used as the reference point for calculating the Tornquist-Theil Index, which yields a comparative TFP index.⁷ The methodology for constructing the TFP index is described in detail in Thirtle *et al* (1993).

Table 6: Relative Total Factor Productivity and Labor/Machinery Indices, by Farm Size

Region / Item	Farm Size (Hectares)			
	<5	5-10	10-15	>15
Region 1: Stoleczny				
Total Factor Productivity*	138.4	140.2	147.0	100.0
Labor/Machinery Ratio*	118.3	127.1	139.7	100.0
Region 8: Srodkowo-Zachodni				
Total Factor Productivity*	111.6	110.7	121.7	100.0
Labor/Machinery Ratio*	126.8	131.4	125.5	100.0

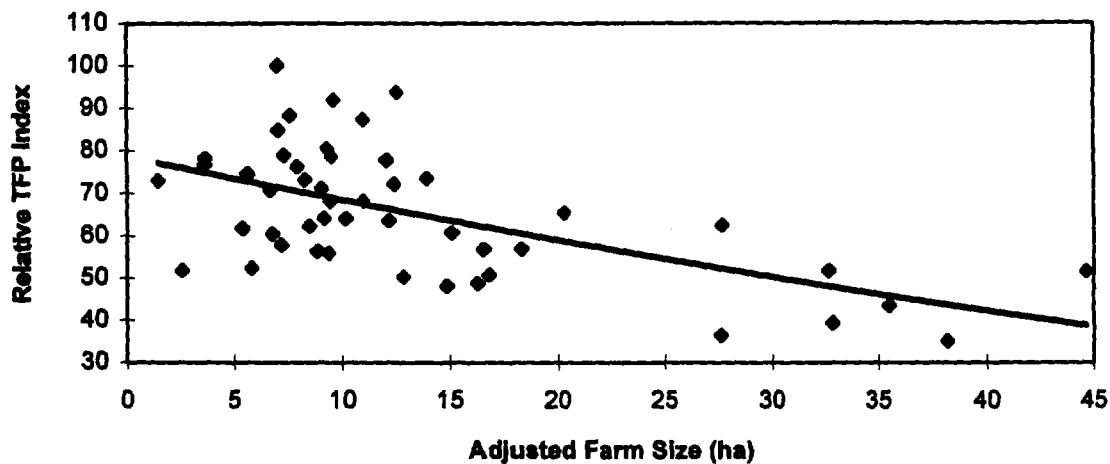
Notes: * TFP index and labor/machinery ratio of large farms (>15 ha) are the norms (100) against which the other size categories were compared.

Analysis indicates that the differences in both TFP and labor/machinery ratios between the farm size categories smaller than 15 hectares and larger than 15 hectares are statistically significant at the 10 percent level, while differences between the farm size categories smaller than 15 hectares are not statistically

significant at the 10 percent level (Table 6). The finding yields a downward sloping curve for TFP with respect to farm size (Figure 1).

Within the sample of farms analyzed, the results are clear: (i) large farms are not more efficient than smaller farms, particularly those within the 10-15 hectares range; and (ii) smaller farms have a larger labor/machinery ratio than large farms, indicating that they are relatively more labor intensive in their mode of production.

Figure 1: Relative Total Factor Productivity per farm size in the Stoleczny Region of Poland, 1993



Social Total Factor Productivity Analysis

Using market prices to measure productivity assesses differences in private efficiency, while the use of social opportunity costs as a measure eliminates the impact of distortion and measures differences in social efficiency. Few studies, none of them in Poland, has made this distinction in the analysis of the farm size-efficiency relationship. In the period under consideration, the price of capital was distorted by several factors, including tax benefits and interest rate subsidies. This

contributed, amongst other things, to over-capitalization of larger farms relative to smaller ones (Table 6); output prices were also distorted due to protection and market price support,⁸ with larger farms benefiting disproportionately. Accounting for these distortions is thus important when looking at farm structure and production relations from a social perspective.

To account for these distortions, social efficiency estimates were calculated for farms in the two samples. Social opportunity costs for capital, labor, variable farm inputs and farm outputs (both crops and livestock) were obtained from previous studies and verified through discussions with government officials and World Bank staff. The TFP analysis of each farm was repeated using these social opportunity costs rather than private costs (Table 7).

The results obtained from the social TFP analyses suggest that: (i) average social TFP is lower than average private TFP in both regions; and (ii) large farms (> 15 hectares) are more inefficient relative to smaller farms when social opportunity costs are taken into account.

The reason large farms are more inefficient stems mainly from differences in the relative importance of labor and capital in the input mix of large and small farms. The value of output of small and large farms is generally affected in a similar manner because the ratio of livestock to crops does not differ significantly between these groups, but the input mix varies considerably, with large farms being relatively more capital intensive and small farms being relatively more labor intensive. Because the social opportunity cost of labor is lower than the actual wage

rate due to high rural unemployment, but the social opportunity cost for capital is higher than the actual prices farmers face, the total value of inputs increases more for large farms than for small farms.

Table 7: Social Relative Total Factor Productivity by Farm Size

Region	Farm Size (Hectares)				Average Social/Private TFP Ratio
	< 5	5 - 10	10 - 15	> 15	
<u>Region 1:</u> Stoleczny	145.8	150.4	159.6	100.0	0.87
<u>Region 8:</u> Srodkowo-Zachodni	120.4	121.9	131.2	100.0	0.89

Notes: * Four farm size categories were defined for each dataset.

 ** TFP index and labor/machinery ratio of large farms (>15 ha) are the norms (100) against which the other size categories were compared.

The results of the social TFP analysis should be interpreted with care. Farmers react to the incentive structure facing them, and if capital is relatively cheaper, they use more of it, and *vice versa*. For this reason the social TFP calculations are more indicative of the distortions than the actual social costs or efficiency losses.

Changing the values from private to social prices strictly does nothing to the physical input and output ratio, and TFP stays essentially the same, although the weighting of the inputs and outputs change. However, the point here is to determine to what an extent farm size influences the farmer's ability to capture benefits and utilize the incentive structure.

Non-parametric Efficiency Estimation Using Data Envelope Analysis (DEA)

The analysis of efficiency has fallen into two broad categories: parametric and non-parametric. The first approach relies on a parametric specification of the production function, cost function or profit function (Forsund *et al*, 1980; Bauer, 1990).

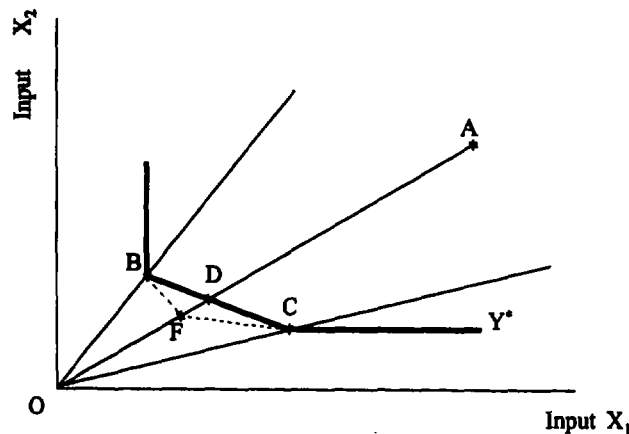
Alternatively, production efficiency analysis can rely on non-parametric methods (Seiford and Thrall, 1990). Building on the work of Farrell (1957) and Afriat (1972), the non-parametric approach has the advantage of imposing no *a priori* parametric restrictions on the underlying technology (Fare *et al*, 1985). It can also easily handle disaggregated inputs and multiple output technologies. As the non-parametric approach develops, its applications for production analysis have become more refined (Chavas and Aliber, 1993), thus providing new opportunities for empirical analysis of economic efficiency.

Non-parametric scale efficiency (SE) measures were developed in response to the earlier work on technical efficiency (TE) and allocative efficiency (AE) (Baumol *et al*, 1982). While TE and AE take the output level as given, SE is concerned with choosing the output level itself. The key question becomes whether firms are operating under decreasing, increasing, or constant returns to scale (CRTS). SE takes on values between 0 and 1, where $SE=1$ identifies scale efficiency under (local) CRTS. Finding $SE<1$ means that the firm is not scale efficient, i.e., does not produce at a scale exhibiting local CRTS. In this context, $(1-SE)$ can be interpreted as the relative decrease in average cost obtainable from rescaling outputs to the point of (locally) CRTS.

The formulation of the non-parametric programming problem for this analysis is based on the work of Chavas and Aliber (1993) and is therefore not repeated in its entirety. Essentially, data envelope analysis (DEA) uses a linear programming procedure to minimize inputs per unit of output to determine the frontier of best-practice farms, and then to determine the efficiency of all the production units relative to the frontier. This estimation approach is preferred to econometric modeling where the techniques impose a functional form, and having zeros for some inputs can cause problems (Nunamaker, 1985; Ali and Seiford, 1993).

The non-parametric Farrell technical efficiency measure is defined as the locus of the efficient points using the minimum required inputs to produce the unit level of output. The efficiency of the other farms is measured relative to this isoquant (Figure 2).

Figure 2 : Farrel Efficiency Measurement



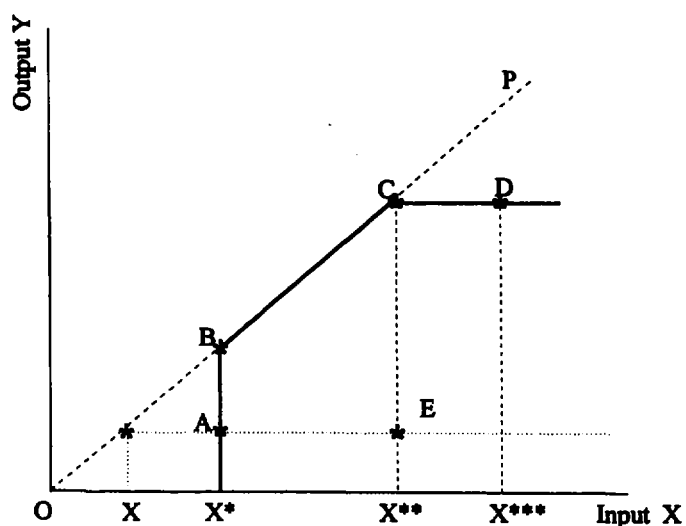
The efficiency frontier unit isoquant is determined by the linear combination of just two efficient farms, B and C, and is labeled Y^* . The efficiency of a farm such as A, that is not on the frontier, is measured by the ratio OD/OA , since OD is the vector

representing the lowest mix of inputs that farm A could use and still reach the isoquant, using its own factor combination.

Efficiency measures for the Polish data provide an assessment of aggregate, total efficiency, and include both technical and scale effects. As our interest is primarily on the farm-size—efficiency relationship, it is important to separate out the effects of farm size on efficiency (Figure 3). The effect of this decomposition is covered by Fare *et al* (1985), while Piesse *et al* (1995) and Van Schalkwyk *et al* (1993) provide empirical applications.

CRTS technology is denoted by the linear total product curve, OP, from the origin, through the efficient production units B and C. Units A and D, in this example, are inefficient as they are below the CRTS frontier. When non-constant returns to scale are allowed for, the frontier (ABCD) is concave, and the input-output combinations A, B, C and D are all technically efficient.

Figure 3: Decomposition of Technical and Scale Efficiency



When technical efficiency is extracted from total efficiency, only the scale effect remains. Thus, farm A is scale inefficient by OX/OX^* , due to being too small, but is technically efficient. Farm D is similarly technically efficient, but is too large and is scale inefficient by OX^{**}/OX^{***} . Finally, farm E is technically inefficient by OX^*/OX^{**} and scale inefficient by OX/OX^* , giving a total level of inefficiency, relative to the CRTS frontier, of OX/OX^{**} .

Results

DEA analysis has been used to estimate the farm size-efficiency relationship in Poland for the data described earlier.⁹ In particular, the scale efficiency of each of the farms is determined relative to that of all other farms in the same region (Table 8).

**Table 8: Average Technical and Allocative Efficiency Results
by Different Farm Size Categories
(1.00 = Efficient)**

Efficiency	Region	< 5 ha	5 - 10 ha	10 - 15 ha	> 15 ha
Technical (TE)	Region 1	1.000	0.971	0.981	0.939
	Region 8	1.000	0.980	0.980	0.955
Scale (SE)	Region 1	0.996	0.982	0.983	0.971
	Region 8	0.994	0.966	0.999	0.982
Allocative (AE)	Region 1	0.735	0.728	0.741	0.724
	Region 8	0.788	0.815	0.804	0.790
Total (TE*SE*AE)	Region 1	0.732	0.694	0.689	0.660
	Region 8	0.783	0.771	0.787	0.741

The results are, to some extent, similar to those obtained with the TFP analyses. Large farms (>15 hectares) are in general less efficient than smaller farms (<15 hectares). However, the results of the different efficiency measure are mixed. Insignificant differences between mean farm sizes of scale efficient (SE-eff) and inefficient (SE-ineff) farms ($p < 0.10$) were obtained for both regions, as well as for the different farm size categories. The results for allocative efficiency (AE) were similar, yielding no significant differences (at the 10 percent level). On the other hand, large farms (>15 hectares) were significantly ($p < 0.10$) less technically efficient than smaller farms.

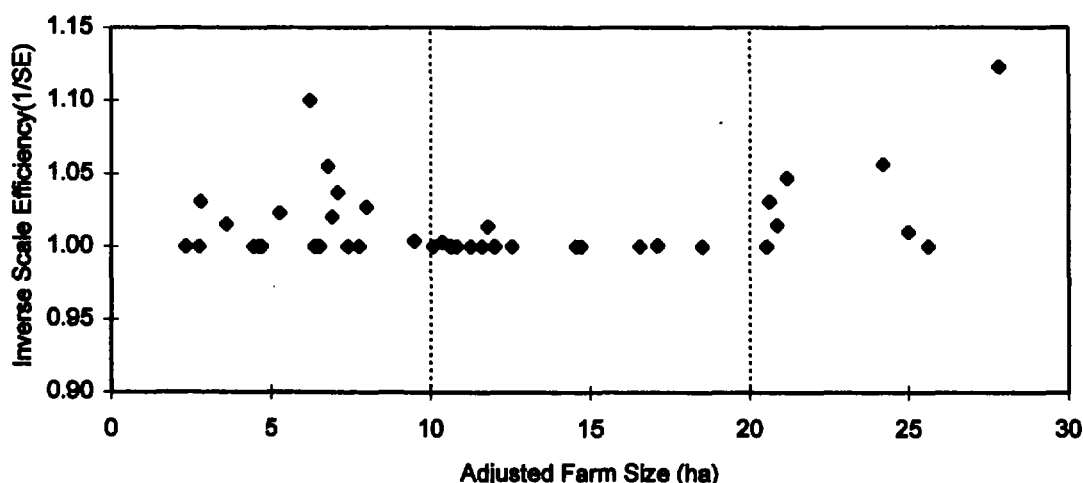
The reason for the perceived inconsistency between the results obtained with the TFP and the DEA methodology may be attributed to the inherent differences in the methodology. DEA isolates scale efficiency from technical and allocative efficiency, while TFP measurements do not differentiate between them.

The conclusions from the DEA analysis with respect to scale are: (i) differences between scale efficiency for large farms (>15 hectares) and smaller farms (< 15 hectares) are not significant; (ii) large farms (> 15 hectares) are technically significantly less efficient than smaller farms; and (iii) total efficiency ($SE \cdot TE \cdot AE$) of large farms (>15 hectares) is does not differ significantly from that of smaller farms.

The inverse of the scale efficiency measure ($1/SE$) has been investigated by plotting it against quality-adjusted farm size to present visually scale efficiency (Figure 4). Following Chavas and Aliber (1993), this inverse can be interpreted as something

akin to an average cost function, i.e., it is a declining function of outputs under increasing returns to scale (IRTS) and an increasing function of outputs under decreasing returns to scale (DRTS). Initially, efficiency increases as farm size increases, depicted by the down-sloping section of the curve for farm sizes less than 10 hectares. This is followed by horizontal section in the curve where scale efficiency is at its highest. Eventually scale efficiency decreases again as farm size become larger than 20 hectares. From the figure it appears that the optimal farm size in the Srodkowo-Zachodni Region of Poland seems to be in the range of 10-20 hectares.

Figure 4: Inverse Scale Efficiency Per Farm Size in the Srodkowo-Zachodni Region of Poland, 1993.



Conclusions and Implications for Farm Restructuring

Despite a history of policies favoring relatively larger, mechanized farms in Poland, the results show that, within the sample of farms analyzed, (i) large farms are not more efficient than smaller farms, particularly those within the 10-15 hectares range; and (ii) smaller farms have a larger labor/machinery ratio than large farms, indicating that they are relatively more labor intensive in their mode of production.

These results are in accordance with empirical evidence on the farm size-efficiency relationship elsewhere in the world. It is somewhat surprising, however, that the range of scale-efficient farms is relatively small. General experience indicates that inefficiencies usually set in after a much wider range of optimal farm sizes.

These results have important policy implications with respect to farm restructuring for Poland and other transition economies facing similar issues and conditions. The results imply that there will be *no efficiency losses if large mechanized farms are restructured into smaller units*. On the contrary, there may well be some efficiency gains. Moreover, such a process will lead to *more labor intensive processes* that will be beneficial in an environment where unemployment and capital scarcity are severe constraints to production. It also illustrates that the consolidation present policy of consolidating small farms into larger units should be reconsidered. The results suggest that *the most appropriate policies are those that support a flexible farm structure with a range of farm sizes where market factors and managerial ability determine individual size preferences*.

An important element in the promotion of such a flexible structure is to get the system of incentives right. This implies the *removal of policies and distortions favoring larger farms over smaller farms*. The basic principle should be to make markets work by removing distortions and privileges favoring large farms, and creating markets to service small farmers in areas where they are missing. This should be done without entrenching new privileges. Imperfect markets should be encouraged to work better.

Notes

¹ Under certain circumstances, such as those in Poland, there are external economies of scale (Johnson and Ruttan, 1994). These occur when firms or farms, as they increase in size, experience advantages in terms of access to inputs, credit, services, storage facilities, or marketing and distribution opportunities relative to smaller farms. This gives large farms real advantages relative to small farms due to pecuniary economies or policy distortions rather than to greater efficiency. On the other hand, diseconomies of scale may also occur, for example when the labor market fails or do not exist, when transaction costs in the labor market are high, or when the effort of hired labor is significantly affected by supervision (De Janvry, 1987).

² See Guba *et al* (1995) and Wei *et al* (1995) for recent developments in input and output markets.

³ The land classification system distinguishes between six different classes of land for arable land and pastures. The land tax coefficients, which were used to compare and normalize the different land classes are: Class I = 1.8; Class II = 1.5; Class III = 1.3, IIIa and IIIb have values of 1.25 and 1.35, respectively; Class IV = 1.0, IVa and IVb have values of 1.05 and 0.95, respectively; Class V = 0.8; and Class VI = 0.5. The normalized land area adjusted for quality is expressed in land class IV equivalents.

⁴ The normalized, quality adjusted land area is expressed in Land Class IV equivalents. However, there has been some recent criticism against the use of the land tax equivalents based on the land classification system as this does not in all cases accurately reflect the real value and production potential of land (Kazimierz, 1986). However, for lack of any other acceptable methodology, this was applied in this study to adjust for land quality

differences. Testing the results by applying the Delphi technique shows that this methodology is appropriate for the two cases/regions under consideration.

⁵ This amounts to assuming that the corresponding implicit price indexes are unity. This approach has the advantage of being empirically tractable. Although it allows for price variation across years and areas, it has the disadvantage of neglecting price variations across farms within any particular survey. While the intuition is that these variations are small or even negligible, they cannot be ruled out. The "rule of one price" (Chavas and Aliber, 1993) does, for example, not take into account different transaction costs or market failures. The assumption that all farmers within a survey face the same prices seem to reasonable given the nature of the farm support system in these areas. An additional, but related point is that the "rule of one price" implicitly accounts for commodities that are not of homogeneous quality. Different farmers may face different prices because they purchase inputs or sell outputs of different quality. By using the monetary values of input and output as quantities, there is an adjustment for these quality differences.

⁶ To convert the stocks, namely land, buildings, livestock and machinery, into annual flows, discount rates for these inputs based on the economic rate of depreciation (10 years for machinery and 25 years for buildings), the interest rate on the relevant annuities, and the pertinent tax rate were all calculated and multiplied by the market value of each asset. The Jorgensen approach was used to determine the cost of capital for the conversions of the stocks to annual flows.

⁷ See Ball, Bureau and Butault (1994) for a review of the properties and recommendations on the selection of different index numbers based on the axiomatic and economic approaches. Following from this, the Tornquist-Theil methodology is appropriate for this analysis.

⁸ See World Bank (1990; 1991) for a synopsis of these policies and their effects.

⁹ The non-parametric analysis of efficiency benefited from discussions with and suggestions by Jean-Paul Chavas from the University of Wisconsin-Madison. He developed the initial GAMS code for the analysis.

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